DOCUMENT RESUME

ED 256 610 SE 045 544

TITLE Safety and Science Teaching.
INSTITUTION Virginia State Dept. of Education, Richmond. Div. of Sciences and Elementary Administration.
PUB DATE May 84
NOTE 64p.
PUB TYPE Guides - Non-Classroom Use (055) -- Reports - Descriptive (141)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Accident Prevention; Biology; *Chemistry; Educational Facilities Planning; *Hazardous Materials; Laboratory Animals; *Laboratory Safety; Needs Assessment; Physics; *School Safety; Science Education; Secondary Education; *Secondary School Science; Storage; Waste Disposal
IDENTIFIERS *Hazards

ABSTRACT

This 10-chapter handbook (designed for science teachers and school administrators) describes known hazards associated with science teaching and provides information to develop a framework for local safety programs specifically designed to avoid or neutralize the effects of such hazards. Major areas addressed in the chapters include: (1) the nature of the problem; (2) uses of chemical, activity, and safety equipment inventories to assess safety needs; (3) physical hazards, health hazards, and hazard alerts; (4) planning for safety (including post-accident procedures and guidelines for modifying curriculum and instructional strategies); (5) chemical hazard control (examining purchasing, recordkeeping, storage, environmental protection, and the use, disposal, and labeling of chemicals; (6) potential hazards, control procedures, and first-aid measures related to laboratory animals, microorganisms, blood letting experiments, and field studies; (7) hazards and control procedures related to fire, radiation, model rocketry, extra-curricular activities, and student errands; (8) eye and face protection; (9) documentation (including inventories, accident reports, safety instruction records, and others); and (10) safety considerations related to the design of science laboratories. Supporting documentation, including a list of chemical hazards (positive carcinogens, suspected carcinogens, highly toxic poisons, and explosives/flammables) is included in appendices. (JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

ED256610

SE 045 541

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
H. L. Smith
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

ACKNOWLEDGMENT

This handbook has been made possible through the concentrated efforts of many individuals and organizations. A special note of appreciation is extended to all those who have contributed.

SCIENCE FACILITIES ADVISORY COMMITTEE

John P. Hamill
Supervisor (Retired)
Energy and Facilities Service
Virginia Department of Education
Richmond, VA 23219

Sandra Morse
Bureau of Toxic Substances Information
Virginia Department of Health
Richmond, VA 23219

Elliot A. Scruggs, Director
Industrial Safety Division
Virginia Department of Labor and Industry
Richmond, VA 23241

F. Roger Sippman
Regional Sales Manager
Sheldon Products
Decatur, GA 30034

James N. Stover
Superintendent
Richmond County Schools
Warsaw, VA 22572

H. H. Summers, Jr.
Chief Fire Marshal
Office of State Fire Marshal
Department of Housing and Community Development
Richmond, VA 23219

ORGANIZATIONS

Council of State Science Supervisors
National Society to Prevent Blindness (Virginia Affiliate)
National Institute for Occupational Safety and Health
Virginia Association of Science Teachers
Virginia Science Supervisors Association

Appreciation is extended to the teachers of Alleghany County, Carroll County, Lee County, Pulaski County, and Tazewell County whose participation in the CS³-NIOSH Safety Course and their implementation of safety practices in the classroom provided the field test for this handbook.

A special note of thanks is extended to David Partington, assistant principal, Patrick Henry High School, Roanoke, and to Franklin D. Kizer, supervisor of science (retired), Virginia Department of Education, for their advice and counsel.

SCIENCE SERVICE STAFF

Dr. Joseph D. Exline
Associate Director

Timothy W. Cotman
Supervisor of Science

Dr. David Andrews
Supervisor of Science

Dr. C. Dillard Haley
Supervisor of Science

BEST COPY AVAILABLE

SAFETY AND SCIENCE TEACHING

Commonwealth of Virginia
Department of Education
Division of Sciences
and Elementary Administration
Richmond, Va. 23216
May 1984

PREFACE

This handbook was developed to fill a need for concise safety information for science teachers and school administrators. The two basic goals are (1) to describe in detail known hazards associated with the teaching of science and (2) to develop a framework for local safety programs specifically designed to avoid or neutralize the effects of such hazards.

The handbook is designed to provide a foundation for safe education in science. It represents the cumulative experiences of classroom teachers, administrators, industrial safety engineers, industrial hygienist, state and federal health agencies, and personnel engaged in enforcing the Occupational Safety and Health Act of 1970 (OSHA). It is anticipated that as new hazards are encountered, the awareness of these hazards and appropriate control measures will be shared among science educators.

The hazards described in this manual have been experienced by people. The control procedures and safety programs have been successfully initiated in industry and/or the classroom. Modifications of these procedures or entirely new procedures are encouraged to insure the safety of students and to share with fellow educators.

TABLE OF CONTENTS

CHAPTER I. THE PROBLEM 1
Motivation for Safety 1
The Student 2
The Teacher 2
The Administration 2

CHAPTER II. ASSESSING NEEDS 3
The Chemical Inventory 3
The Safety Inventory 3
The Activity Inventory 4

CHAPTER III. HAZARD RECOGNITION 5
Physical Hazards 5
Health Hazards 7
Hazard Alerts 8

CHAPTER IV. PLANNING FOR SAFETY 10
The Planners 10
Assignment of Duties 10
Parameters of Student Conduct 11
Procedures for Procurement, Storage, Handling, and Use of Hazardous Materials 11
Post-Accident Procedures 12
Guidelines for Classroom Planning — Selection of Curriculum 12
Guidelines for Classroom Planning — Modification of Curriculum and Instructional Strategies 13

CHAPTER V. CHEMICAL HAZARD CONTROL 14
Purchasing 14
Recordkeeping 15
Storage 15
Environmental Protection 15
Fire Protection 16
Other Storage Precautions 16
Use of Chemicals 16
Disposal of Chemicals 18
Labeling of Chemicals 19

CHAPTER VI. BIOLOGICAL AND ENVIRONMENTAL HAZARD CONTROL 21
Laboratory Animals 21
Microorganisms 22
Blood Letting Experiments 23
Field Study 23

CHAPTER VII. OTHER HAZARDS AND CONTROL PROCEDURES 26
Fire 26
Fire Classification 26
Fire Prevention 26
Fire Control 27
Emergency Procedures 27

Radiation 28
Model Rocketry 29
Co-Curricular Hazards 29
Student Errands 30

CHAPTER VIII. EYE AND FACE PROTECTION 31
Eye-Protective Devices 32
Eyewash Fountains 32
Management Procedures 32

CHAPTER IX. DOCUMENTATION 34
Inventories 34
Personnel Protective Equipment Records 34
Equipment Maintenance Records 34
Accident Reports 35
Safety Instruction Records 35
Fire Extinguisher Records 35

CHAPTER X. DESIGNING FOR SAFETY 39
Laboratory Construction 39
Specific Recommendations 39
Storage Space 40
Special Storage Considerations 41
Special Recommendations 41
Safety Equipment 41

REFERENCES 42

APPENDICES 43
Appendix A. Chemical Hazards 43
Appendix B. National Society for the Prevention of Blindness Position Statement on Contact Lens 50
Appendix C. Activity Inventory 52
Appendix D. Laboratory Safety Checklist 54

Chapter I
THE PROBLEM

Teachers and administrators want to create the safest learning environment possible. Each is dedicated to the premise that no action will be taken to jeopardize the health of a student. The determination of action to take or not to take requires knowledge of the risks involved. Such knowledge can be accumulated by sharing the experiences of teachers, administrators, health department officials, and industrial safety experts. It is the purpose of this manual to provide a summary of safety information relevant to public school teachers and administrators. Such information can serve as the foundation for a school (or division-based) safety policy.

A safer environment can be created by (1) learning to recognize hazards, (2) identifying hazardous activities, (3) eliminating hazards, and (4) controlling hazards. Each of these steps can be approached by focusing on hazard categories. Crunkilton and Grant (1978)[2] indicate that there are six high risk activities in the school:

1. Recreational activities on the playground, school grounds, and athletic fields.
2. Competitive athletic events;
3. Physical education activities;
4. Laboratory and shop activities;
5. Student errands;
6. Off-campus learning activities (field trips).

The science program involves half of these high risk activities. Science activities are diverse and are more difficult to supervise than a traditional classroom lecture. In addition, the environment will contain more material and equipment which is potentially hazardous.

A science safety policy can be a major factor in creating a safer environment for the science program, especially if it is part of a larger plan encompassing all high risk areas of the school.

Motivation for Safety

Ignorance, carelessness, and apathy are contributing factors in most accidents and exposures to health hazards. The Occupational Health and Safety Act of 1970 has greatly increased public awareness of health and safety hazards. Medical, health, and other professional organizations have provided information on specific hazards. A change in each individual attitude will be required to alleviate carelessness and apathy. Each person involved in an activity should have a vested interest in personal safety.

The Student

Each student has three major interests which, when channeled properly, will encourage the acquisition of knowledge about safety, the development of correct safety practices, and the dissapation of apathy. No person wishes to injure others or to be injured. A student must also consider establishing credentials which will increase the prospects of securing a rewarding job. The student should be made aware that industry wants employees who can and will function safely. These three factors, once brought to the students' attention, should prove sufficient motivators for learning safe procedures. Students should be informed that the industrial and business world is interested in employees who are safety conscious.

The Teacher

Every teacher wants to create a safer environment for learning. A healthy graduate who has learned safe practices within the curriculum should be reward enough. Ignorance, carelessness, or apathy can result in civil litigation by an injured student or the student's parents.

The Administration

Each principal, supervisor, or superintendent likes to feel that the best possible education takes place in the school. Public confidence in the school is necessary to its operation. Few injuries and minor property damage are one indication of a good school system. It is certainly in their best interests that school superintendents, principals, and school boards be involved in planning for a safe and healthful school environment.

Chapter II
ASSESSING NEEDS

Recognition, control, or elimination of hazards and hazardous activities require that one knows what to look for and where. It is imperative that an assessment of the learning environment be made. Complete inventories are recommended as an appropriate means of accomplishing this task. Three types of inventory are suggested for assessing safety needs; the chemical inventory, the activity inventory, and the safety equipment inventory.

The Chemical Inventory

Science teachers and the building principal should be aware of the chemical substances in the school. A chemical inventory must be taken at least once a year to be useful. The chemical name of the substance and the amount on hand must be listed. It is also important that the inventory state the location where each chemical is stored. Additional information necessary for the inventory includes: (1) purchase date of the chemical, (2) name of supplier, (3) potential hazards, and (4) program in which used.

This type of inventory allows for rapid identification of a hazardous chemical. As an example, the release of information identifying a newly documented carcinogen could be handled quickly through an inventory search. One should not have to search through the laboratory and stockroom to determine if the carcinogen is there.

The Safety Inventory

This inventory involves an assessment of the safety features of the laboratory and should include the number, location, and type of the following equipment:

1. Fire extinguishers;
2. Fire blankets;
3. Master controls (emergency controls for gas and electricity);
4. Fume hoods;
5. Eye safety devices (goggles, face shields);
6. Exits;
7. Body shields;
8. Protective clothing (aprons, gloves, laboratory coats);
9. Safety showers;

10. Eye wash fountains; and
11. Safe waste containers.

Each item included in this inventory should be fully operational. A malfunctioning piece of safety equipment will be useless in an emergency. The absence of appropriate safety equipment will make some student activities excessively hazardous.

The Activity Inventory

This inventory lists all student activities in the science department. It covers four categories: (1) formal student activities (regular laboratory experiments), (2) informal or enrichment activities (project work, science fair experiments, home assignments), (3) student errands, and (4) field trips.

1. The formal student laboratory section of the activity inventory should include:
   a. A list of all laboratory activities scheduled for each course offered within the department;
   b. A brief description of the procedures involved in conducting the activity;
   c. A list of chemicals and equipment necessary to conduct each activity;
   d. A list of all cautions or safety statements included in the text and laboratory manual.

2. The informal enrichment activities section of the activity inventory should include:
   a. A list of science projects or types of projects which will be sponsored by department personnel;
   b. A statement of rules or regulations governing the construction or production of student projects;
   c. A definition of the working environment in which the student prepares the project (laboratory project room, home basement, etc.);
   d. A list of the chemicals, materials, and equipment which would be provided.

3. The student errand category should include:
   a. A list of the type of duties to which students are assigned and the frequency of such duties;
   b. Guidelines governing the use of students to do errands.

4. The field trip category should include:
   a. A list of field trips by subject area;
   b. A concise description of the environment for specific field trips (example, biology — natural area studies, list hazardous flora and fauna, terrain, footbridges, deep water, etc.);
   c. A list of equipment to be used on field trips, (i.e., rock chipping hammers);
   d. A statement of rules or regulations governing student conduct on field trips.

These inventories can serve as a starting point for promoting awareness of the importance of safety. Other types of information will prove useful. A subjective evaluation of the type and condition of the laboratories and classrooms is invaluable. This curriculum should include an appraisal of class size relative to the teaching space available, arrangement of student stations, condition and availability of services, and scheduling procedures.

This information, once assembled, can be evaluated to determine whether hazardous materials or hazardous conditions exists.

Chapter III
HAZARD RECOGNITION

Hazards can be classified into two broad types . . . physical and health. Hazards which are associated with accidents are classified as physical hazards. In this category are materials and situations which can expose students to fires, explosions, falls, cuts, burns, poisonings, and other immediate dangers.

Hazards which have no immediate noticeable effect and which cause no disruption in instructional programs are classified as health hazards. These hazards include toxic substances which may cause cancer, birth defects, nerve damage, and other health impairments years after the person is exposed to them. Exposure to health hazards may be accidental but more often is the result of ignorance of the existence of the hazard.

Physical Hazards

Physical hazards are diverse in type. Some types exist in almost all environments, others may be restricted to specialized environments. In the public school, the greatest potential for physical hazards exists in physical science classes. Large numbers of students, lack of safety engineered equipment and facilities, and the relative lack of training in chemistry by middle school and elementary school teachers tend to accentuate hazards in physical science programs.

Before a hazard can be recognized, one must (1) identify the injuries which can be prevented, (2) identify and classify equipment and substances which cause injuries when misused, and (3) identify activities of the student or teacher which have a relatively high probability of leading to injury.

1. Injuries due to impact are caused by a collision between a person and an object or objects. Causes of such impacts are falls, falling objects, explosions, implosions, and propelled objects.

   a. Falls — These can be caused by faulty equipment including stairs, ladders, step stools, or by hazardous activities such as climbing on chairs.

   b. Falling objects — Those include precariously balanced objects stored on tables or high shelves, loose rocks, and tree limbs.

   c. Explosions — The three well-known sources of explosions are rapid chemical decomposition of an unstable substance, rapid chemical combination of one or more substances, and the rupture of a pressurized container. Substances which can cause explosions by rapid decomposition are normally labeled explosive. The *Merck Index* and the *Laboratory Waste Disposal Manual* are recommended sources for determining if a material is explosive. Many of the explosive compounds which may be found in a school laboratory are listed in Appendix A. Examples of such compounds are gun-

powder, peroxides, and nitro compounds such as nitrocellulose and picric acid.

The violent chemical reaction of two or more substances is easy to recognize. However, since the hazard arises only when the materials are mixed, the individual material often carries no apparent warning. Some individual components are identified in Appendix A and in the *Merck Index* as materials which form explosive mixtures. In other sources, the term "incompatible chemicals" may be used to identify these substances.

Hazardous activities include mixing:

1. Oxidizing agents with reducing agents;
2. Oxidizing agents with organic materials;
3. Oxidizing agents with powdered metals;
4. Alkali metals with water;
5. Alkali metals with acids;
6. Alkali metals with nonmetallic chlorides;
7. Concentrated acids with concentrated alkalies;
8. Metal hydrides with water.

Substances identified as flammable also form explosive mixtures with air.

Any container which is used for holding a substance under pressure can explode. Commercially-available pressurized containers for hair sprays, shaving foams, and compressed gases are hazards at high temperatures. Heating a substance in a closed container and similar activities can result in explosions. Similar activities involving open containers can be classified as hazards if the container can be accidently closed.

d. Implosions — An activity which may create a vacuum within a container made of non-ductile material is hazardous. Rapid contraction of a brittle material (red-hot glass, ceramic, or rocks rapidly cooled) can cause the material to shatter.

e. Propelled objects — This category includes all objects set in motion by means other than gravity, explosions, or implosions. Elastic materials (springs and rubber bands) which are used to propel objects in many physics and physical science experiments are potential hazards. The potential for student misuse (horseplay) of the materials used for these experiments should be considered. Activities which allow the use by students of objects easily thrown (rubber stoppers) are also potential hazards.

2. Injuries due to burns result in destruction of surface tissues. The injuries may arise from exposure to high temperature or from chemicals coming into contact with tissue.

   a. Thermal burns — Hazardous activities include heating liquids, bending and shaping glassware, and using laboratory heat sources. All flammable liquids should be considered as potential sources of severe burns. A flammable liquid is defined by the National Fire Protection Association as any liquid having a flash point below 100°F and a vapor pressure not exceeding 40 psi. When in doubt about the flammability of a substance, contact the *Handbook of Chemistry and Physics* by the Chemical Rubber Publishing Company or a similar handbook.

   b. Chemical burns — Strong acids (sulfuric, nitric) and bases (sodium hydroxide, potassium hydroxide) are frequent sources of chemical burns. Phosphorus, phenol, iodine, and alkali metals are also chemicals that cause burns. There are many other sources of chemical burns in the school laboratory.

3. Cuts and punctures of the skin may result from the students' exposure to glass (tubing, thistle tubes, broken containers) and dissection equipment (scapels, razor blades) used in

instruction. Infection of these wounds is also a hazard.

4. Electrical shock is caused by the flow of an electric current through body tissue. High voltage equipment and standard 110-120 volt circuits are common sources of electrical shock. Hazards include exposed conductors, frayed insulation, faulty grounding circuits, and overloaded circuits. Hazardous activities include making an electrical contact while exposed to conducting fluids, such as plugging into a receptacle with wet hands.

5. Injuries to respiratory and central nervous systems can result from inhalation of toxic gases, fumes, and dust particles. Hazardous chemicals are normally labeled "caution-avoid inhalation of fumes." Examples are chloroform, ethers, chlorine, and toluene. Activities which generate toxic inhalants are also hazards. Such activities include the generation of carbon monoxide, carbon dioxide, hydrogen sulfide, oxides of nitrogen, and chlorine.

6. Poisoning causes internal injuries ranging from reduced functioning of the central nervous system to severe irritation of the gastrointestinal tract. These substances are labeled "POISON." An activity in which a student could accidentally swallow one of these substances is hazardous.

Health Hazards

The identification of health hazards is difficult. Exposure to a health hazard is often unnoticed. A health injury may go undiscovered for years. This makes isolating the cause of the injury very difficult. Determining the manner and extent to which a chemical compound can be injurious to health is expensive and time consuming. In most cases, data have been extrapolated from toxiological studies on laboratory animals or from studies on industrial exposure. For these reasons, health hazard data are sometimes sketchy and speculative. However, a substantial body of validated health hazard information is available. Comparison of chemicals with lists of known health hazards is one means of detecting potential health hazards. Appendix A contains such a list.

Carcinogenic chemicals are the most widely publicized of the health hazards. In January, 1975, OSHA declared the following fourteen substances to be cancer causing:

1. 2-Acetylaminofluorene — believed to cause cancer in humans;
2. 4-Aminodiophenyl — bladder cancer;
3. Benzidine (and its salts) — bladder tumors;
4. Bis-choromethyl ether — lung cancer;
5. 3,3'-Dichlorobenzidine (and its salts) — believed to cause liver, bladder, and breast cancers;
6. 4-Dimethylaminoazobenzene — suspected cause of cancer in humans;
7. Beta-naphthylamine — bladder cancer;
8. 4-Nitrobiphenyl — bladder cancer;
9. N-Nitrosodimethylamine — suspected to cause human cancer;
10. Beta-propiolactone — believed to cause cancer in humans;
11. Methyl chloromethyl ether — believed to cause lung and sub-skin cancers;
12. Alpha-naphthylamine — has been implicated in human bladder cancer;
13. 4,4'-Methylene bis (2-Chloroaniline) — has induced tumors in rats and mice;
14. Ethyleneimine — causes cancer in animals.

In addition, certain forms of asbestos and the compound vinyl chloride are now considered carcinogenic. Many additional chemicals are suspected of contributing to the development of cancer.

Other health hazards can lead to the development of birth defects, chronic heart diseases, chronic lung disorders such as emphysema and black lung, liver and kidney damage, and dysfunction of the central nervous system.

Among these health hazards are the substances mercury, carbon tetrachloride, benzene, and carbon disulfide.

Mercury vapor and dust of mercury compounds are absorbed through the skin and the membranes of the respiratory tract. Chronic mercury poisoning affects the central nervous system and is manifested by muscle tremors, spasms, personality changes, irritability, and depression.

Carbon tetrachloride is toxic by inhalation, ingestion or skin absorption. Liver damage is the most frequently sustained injury, but kidney damage and visual disturbances also occur.

Carbon disulfide is toxic through ingestion, inhalation or skin absorption. Psychic disturbances may result from long term exposure.

Benzene is most toxic by inhalation and skin absorption. The inhalation of benzene vapor can result in damage to the bone marrow. Narcosis and dematitis has resulted from absorption of benzene through the skin.

The list of positive carcinogens released by OSHA and a list of potentially hazardous chemicals (Appendix A) has been disseminated to Virginia schools via superintendents memorandum. It is anticipated that this information on hazards will be updated as needed.

The first step in controlling health hazards is to determine the amounts of chemicals on hand which are hazardous to health. A comparison of the school's chemical inventory with the published lists of chemical hazards can be used. The second step is to identify activities and/or environmental conditions which cause student exposure to the hazard.

In addition to chemical health hazards, there also exists biological and radiological health hazards. These are discussed further in Chapter VI, "Biological and Environmental Hazard Control," and Chapter VII, "Other Hazards and Control Procedures."

Hazard Alerts

Several sources of information indicate potential hazards of materials. One of the easiest to use is the NFPA 704 System. This system developed by the National Fire Protection Association, Boston, Massachusetts, rates three different types of hazards on a numerical scale as described below.

RATING	HEALTH HAZARDS	FLAMMABILITY	REACTIVITY
4	Extreme Health Hazard	Extremely	Extremely
3	High Health Hazard	Highly	Highly
2	Moderate Health Hazard	Moderately Combustible	Moderately
1	Slight Health Hazard	Slightly Combustible	Slightly
0	No Significant Health Hazard	Noncombustible	Nonreactive

A special hazard warning indicates the presence of radioactive, biological, and similar special hazards.

The *Laboratory Waste Disposal Manual,* by the Manufacturing Chemicals Association, and NFPA-49 *Hazardous Chemical Data* utilize this system and are recommended for rapid recognition of chemical hazards.

Labels are a useful source of hazard warnings. Current labels may utilize the NFPA 704 System. Flammables, poisons, caustics, and corrosives should be indicated on container labels. Hazard warnings were not always used on older containers, therefore, DO NOT RELY SOLELY ON THE MANUFACTURER'S LABEL FOR HAZARD WARNINGS.

The above systems are intended to make the user of a chemical alert to potential danger. The *Merck Index* or similar publication can be used to determine the specific hazards of the chemical.

Chapter IV
PLANNING FOR SAFETY

After hazardous conditions are determined, a safety policy emphasizing school management and planning should be formulated and implemented. Procedures for management should include an assignment of responsibilities to school staff; determination of acceptable parameters of student conduct, development of procedures for the procurement, storage, handling, and use of hazardous materials; implementation of a system for inspection and maintenance of facilities and equipment; and adoption of appropriate post-accident procedures. Guidelines for planning should emphasize the selection of a curriculum with minimum hazards. These guidelines also should direct the teacher in the selection, substitution, or modification of learning activities and instructional procedures.

The Planners

The building principal, department chairpersons, and classroom teachers must take the major responsibility in planning for safety. Central office staff, patrons, and safety and/or health consultants also should be involved in the development of the total safety program.

Assignment of Duties

The building principal should:

1. Provide for the proper maintenance or replacement of facilities and equipment to insure the health and safety of the student;
2. Develop emergency procedures that designate an office contact person, provide proper supervision for any class in which the teacher has been distracted by an accident, and make competent medical assistance available;
3. Ensure that appropriate instructional techniques and curricular materials are used by the faculty;
4. Provide, with the assistance of the faculty, alternative educational experiences for students whose conduct pose hazards.

The department chairperson should:

1. Ensure that appropriate inventories are taken and made available to all teachers and principal;
2. Coordinate all purchases to insure that purchase orders are not duplicated, do not specify

greater amounts of hazardous materials than can be used within the approved curriculum during the school year, and that extremely hazardous materials are not ordered;

3. Record, transmit, and follow up all requests for maintenance or replacement of equipment;
4. Assist and support the classroom teacher in determining maintenance needs;
5. Assist and support the classroom teacher in the modification of teaching strategies and curriculum when needed to compensate for the lack of equipment and facilities;
6. Ensure that appropriate safety equipment is in place, storage facilities and procedures are functioning properly, and that approved safety practices are shared with all teachers.

The classroom teacher should:

1. Instruct students as to the potential hazard of an activity and the appropriate procedures for safely completing the activity;
2. Ensure that all equipment to be used by students is functioning properly;
3. Ensure that student activities are appropriate for student background and maturity, safety equipment available, and facilities;
4. Utilize appropriate classroom management techniques to reduce the risk of student exposure to potential hazards;
5. Ensure that all students follow instructions, utilize appropriate procedures, and practice safe modes of behavior.

Parameters of Student Conduct

The standards for student conduct and attendance specified by the "Standards of Quality and Objectives for Public Schools in Virginia" should encompass the necessary parameters for safe conduct in the science program. The achievement of an atmosphere free of threat to person or property should include the threat due to safety hazards.

Specifically, the standards of conduct should:

1. Specify that safety instructions are to be expressly followed;
2. Direct the wearing of safety equipment and specify the conditions in which the equipment be worn;
3. Specify that shoving, fighting, deliberate use of unauthorized chemicals or materials, or similar behavior which could cause injury to persons are forbidden;
4. Provide for the removal of students whose conduct threatens other students from laboratory and field study;
5. Specify such additional rules of conduct as may be necessary to safely implement a defined program of study.

Procedures for Procurement, Storage, Handling, and Use of Hazardous Materials

These procedures should specifically deal with the hazardous materials which are essential for conducting the school's science program. Specific guidelines for this section are discussed in Chapter IV.

Post-Accident Procedures

The post-accident procedures should include emergency procedures, procurement of medical assistance, and documentation.

1. Emergency procedures are those actions taken immediately following an accident to lessen the severity of injuries. Faculty members should be aware of the types of hazards present and anticipate the types of accidents which could occur in a specific laboratory situation. Suggested procedures for assisting accident victims are outlined in Chapters V, VI, and VII. Drills on emergency procedures should be specified for high probability accidents.

2. Procurement of medical assistance should relate specifically to the medical assistance available to the school. The plan should include:

   a. Designation of a school office contact person, and approved procedure for contact;

   b. Medical form for each student specifying that the contact person has parental permission to refer the student to designated medical authorities;

   c. A procedure for immediate notification of parents or guardian;

   d. Designation of appropriate transportation to medical facility when needed, such as rescue squad or ambulance service.

3. Documentation should include the development of and procedures for implementing an accident report form. Accident reports are discussed more extensively in Chapter IX.

Guidelines for Classroom Planning
Selection of Curriculum

Curriculum objectives should be selected to improve learning and reduce hazards to the students. The instructional facilities, the maturity and past behavioral modes of the students, the existence of specific functioning safety equipment, and the training and experience of the classroom teacher should be considered in selecting curriculum objectives. The following general guidelines are suggested for consideration.

1. The generation or release of poisonous or otherwise harmful gases and dusts shall be attempted only if the following conditions are met:

   a. The teacher is endorsed for the teaching of chemistry;

   b. The objective to be met is within the framework of a chemistry or physical science curriculum at the high school (grades 8-12) level;

   c. The activity is conducted within a functioning fumehood.

2. Student use of concentrated corrosives or caustics may be included in the curriculum if:

   a. The teacher is endorsed in the teaching of chemistry;

   b. The objective to be met is within the framework of a chemistry course at the senior high school (grades 10-12) level;

   c. The laboratory is equipped with a functioning eye wash fountain, safety shower, and personal protective equipment (gloves, goggles, aprons, and spill trays).

3. Student use of explosives or explosive mixtures are prohibited. Teacher demonstrations may be used to implement study of such chemical reactions if:
   a. The teacher has a demonstrated knowledge of such reactions;
   b. Body shields capable of withstanding an explosion are available and used correctly.
4. Curricular objectives which are to be attained through the use of carcinogens, teratogens, or mutagens are prohibited.
5. Objectives which are attained through the culture of pathogenic organisms are prohibited.

NOTE: These sample guidelines are suggested as parameters to be considered in program planning. They are not inclusive. Each school must develop guidelines which afford protection from hazardous activities dictated by curriculum for specific conditions in that school.

Guidelines for Classroom Planning — Modification of Curriculum and Instructional Strategies

Essential objectives may pose an unacceptable risk when attained through conventional instruction using improper facilities which lack safety equipment. Either the objective or conventional instruction (as specified in textbooks or laboratory manuals) may sometimes be modified. The prevalent means of modification are:

1. Substitution of a less hazardous material for a high risk material;
2. Substituting a similar chemical reaction with less hazard for a hazardous reaction;
3. Having hazardous components of an activity conducted by the teacher;
4. Conducting teacher demonstrations in lieu of student activity;
5. Substituting audio visuals (single concept film loops, closed circuit television) for the hazardous activity.

Such modifications should be the responsibility of the classroom teacher. The chairperson of the science department and the building principal should be consulted and should concur with the modification. When such aid is needed and requested by the classroom teacher, the building principal should seek the assistance of outside consultants such as from the Virginia Department of Education or local colleges.

Chapter V
CHEMICAL HAZARD CONTROL

Numerous hazards are associated with the use of chemical reagents. These reagents may be: explosive, combustible, poisonous, caustic, or corrosive. Chemical reagents may be hazardous or may become hazardous when misused. Exposure to certain chemicals can cause a deterioration of health over a period of years. Chemicals can be as great a hazard in storage as when actually used in the laboratory. Chemical hazard control should be a total program which includes purchasing, record-keeping, storage, use, and disposal.

Purchasing

A well coordinated purchasing program should insure an adequate supply of essential chemical reagents while screening out nonessential highly hazardous chemicals. All purchases should be coordinated by a designated person, preferably the science department chairperson. This person should:

1. Be capable of assessing the hazards of chemicals;
2. Be sufficiently knowledgeable so as to recognize requests for nonessential chemicals;
3. Have available for use a current inventory of existing chemicals.

A sound policy for purchasing of chemical reagents should include these statements:

1. High risk chemicals shall not be purchased if an effective instructional program can be carried out without them.
   a. It shall be the responsibility of the purchasing coordinator to assess the hazard of a given chemical.
   b. The science faculty with the assistance of the building principal shall reassess the need for any chemical regarded as highly hazardous. Every effort should be made to modify curriculum and instructional procedures to eliminate the need for high risk chemicals.
2. Chemical reagents should be purchased in quantities consistent with rate of use.
   a. Time-sensitive chemicals which form explosive peroxides and react with transient gases to form new compounds or decompose with the passage of time should be purchased only in quantities sufficient for one semester.

b. Quantities of other essential chemicals should not exceed that budgeted for use in a single school year. This is recommended for all chemicals but is essential for chemicals with high reactivity or flammability.

3. All orders shall be checked to eliminate duplication of purchases.

Recordkeeping

Inventories are essential in the control of chemical hazards. An inventory of reagents, safety equipment, and laboratory equipment is needed. It should enable any member of the science department to determine the existence of a specific chemical, its location, and its approximate shelf age.

The chemical inventory should:

1. Identify chemical reagents by name and formula;
2. Specify the amount of each reagent present and the inventory date;
3. Indicate the storage location of each reagent;
4. Indicate the course for which the reagent was ordered;
5. Indicate the hazard of each reagent;
6. Record the purchase date, arrival date, and quantity of all reagents received;
7. Record the date of removal of a reagent from stock.

Inventories of safety equipment and laboratory equipment should enable any member of the science department to quickly determine:

1. Whether appropriate equipment is on hand to control a specific chemical hazard;
2. The location and condition of needed equipment.

Storage

The storage of chemical reagents is a key factor in controlling chemical hazards. There are three major functions which chemical storage facilities must provide:

1. Security -- Unauthorized removal or use of chemicals must be prevented;
2. Environmental protection — Fumes and vapors must be prevented from entering classrooms and laboratories;
3. Fire protection — The chemicals must be protected from fire.

An ideal chemical storage system will fulfill all three functions at minimal cost.

Environmental Protection

Fumes and vapors should be removed from the storeroom to a safe area outside the building. A safe area is defined as having:

1. Low probability of fume or vapor re-entry through air conditioning, heating, or ventilation system;
2. Low probability of human exposure in the area.

Substances which will emit fumes or gases should not be stored in an unventilated stockroom. A stockroom which has been closed over a holiday period should be ventilated before entering. Some fumes and vapors present additional hazards and require additional storage precautions.

1. Corrosive vapors — The vapors and fumes must also be vented to the outside to avoid reaching toxic levels. In addition, the buildup of these fumes will cause extensive corrosion of metal fixtures and containers. A corrosion resistant ventilation system should be used. A periodic inspection of chemical containers should be made.
2. Flammable vapors — The vapors from liquids classified as "flammable" form explosive mixtures with air. A "flammable" liquid has a flash point below 100°F and a vapor pressure less than 40 psi at 100°F. The storage area should be free of all sources of ignition. It should include explosion-proof electrical fixtures (light switches and ventilation fan motor) and warning signs prohibiting the use of open flame in the area.

Fire Protection

The fire hazard inherent in chemical storage can be controlled through construction of the storage facility and management of the storage area. Special cabinets are commercially available for the storage of flammables and combustibles (flash point above 100°F) in the laboratory and classroom. Such cabinets must meet the requirements specified by NFPA-30-1973 and be vented to a safe area. A built-in storage facility should also comply with NFPA 30 — 1973.

Fire hazards can be reduced by:

1. Limiting the amount of flammables and combustibles stored;
2. Using safety cans (defined by NFPA-45-1975) for flammable liquids;
3. Separating incompatible chemicals.

Other Storage Precautions

Large containers should be stored on or near the floor. Reagents which are caustic, corrosive, or volatile whould be stored below waist level. Only small containers (one-half liter or less) should be stored on high shelves. No reagent should be stored at a level higher than can be comfortably reached by the teacher.

Chemicals should not be stored in work areas or within the fume hood.

Food should never be taken into a chemical storage area or stored in a laboratory refrigerator.

Flammables may be stored in explosion-proof (all ignition sources sealed) or explosion-safe (interior ignition sources sealed) refrigerators. The standard household refrigerator should never be used in a chemical storage area to store flammables. The unsealed electrical circuits can serve as ignition sources. The explosion-safe refrigerator can serve as an ignition source for flammable vapors originating outside the refrigerator and should not be used in a storeroom where such vapors may be present.

Use of Chemicals

Before beginning a laboratory exercise, know the hazards of the chemicals to be used, appro-

priate safety precautions, and appropriate emergency procedures.

1. Know your chemicals! Using the activity inventory or laboratory manual, determine the name, type, and amount of chemicals to be used in the experiment. Use the procedures in Chapter III to determine the hazard potential.

2. Develop strategies to compensate for chemical hazards.

   a. Approved eye protective devices and protective clothing (aprons, laboratory coats) should be worn by all persons in a laboratory in which chemicals are to be used.

   b. Gloves and face shields should be worn by all persons when chemicals capable of severe tissue damage (chemical burns) are to be used.

   c. Body protective devices (laboratory guards, body shield) should be used when an explosion hazard exists.

   d. A properly operating fume hood should be used for all chemical reactions which may generate toxic fumes, vapors, or dusts.

   e. Chemicals which are highly caustic or corrosive should be used only if an eyewash fountain is available and functioning properly.

   f. If highly caustic or corrosive chemicals are to be used in large enough amounts to splash on a major portion of the body, a functioning safety shower should be available.

   g. The students should be carefully and explicitly instructed in safe procedures including the nature of the hazard, the proper procedures for conducting the activity, the proper use of the safety equipment, and appropriate laboratory conduct.

   h. The students should be instructed in the proper use of poisonous chemicals.

   DO NOT ASSIGN AN EXPERIMENT IF EQUIPMENT IS NOT AVAILABLE TO COMPENSATE FOR A CHEMICAL HAZARD.

3. Procedures for laboratory emergencies should be developed as described in NFPA-45-1975. These procedures should include alarm actuation, evacuation, and first aid for specific types of injuries.

   a. Alarm actuation — Notify the designated contact person in the school office. The intercom should be used if available. If the accident imperils more than the immediate class, activate the fire alarm system.

   b. Evacuation — The plan should be written with an accompanying diagram and posted in each laboratory. The evacuation plan should include:

      (1) The conditions under which the laboratory will be evacuated;

      (2) The method of contacting the school office;

      (3) Action to be taken upon being ordered to evacuate (shut off gas, electrical equipment, close windows, doors);

      (4) Exit routes including alternate route;

(5) The person charged with counting of students when class reaches designated safe zone.

c. First aid — the plan should specify immediate action to prevent further injury after an accident. The plan should include specific directions for obtaining professional medical services for the injured. The following types of first-aid procedures may be necessary.

(1) Clothing fire — Instruct students in NFPA recommended procedure until it becomes second nature. The injured party must STOP, DROP to the floor, and ROLL. The other students and teacher must be prepared to push the injured student to the floor and roll that student to smother the flames. Safety showers or fire blankets should be used ONLY if immediately at hand. In all events NFPA-45 recommends that the student be horizontal to reduce flame damage to face and eyes and to reduce the risk of smoke and heat inhalation.

(2) Laboratory fire — Actuate alarm and evacuate. Use appropriate fire extinguisher to clear a path for evacuation, to put out small fires, or to prevent fire from spreading. The teacher's primary responsibility is the safety of students.

(3) Chemical splash (eye) — Use eyewash fountain or appropriate substitute to immediately flush eye with water. Contact the school office. Continue to flush eye for 15 minutes or until medical assistance arrives.

(4) Chemical splash (body) — If the chemical is capable of causing chemical burns, wash immediately in a safety shower.

EXCEPTION: Water reactive chemicals require special precautions and instructions. Do not expose students to this hazard unless preparations have been made to deal specifically with this hazard.

(5) Release of toxic gases — Actuate alarm and evacuate.

(6) Electrical shock — Shut off electricity and contact school office. Give mouth-to-mouth resuscitation if necessary. Treat the victim for shock.

(7) Ingestion of poisonous chemical — Contact the school office immediately. Determine the type and amount of poison ingested and make this information available to medical authorities. ANTIDOTES are frequently recommended on commercially available emergency procedure charts. These should be administered with EXTREME CAUTION only when the appropriate antidote is readily available, the person administering the antidote is familiar with the procedure, the victim is conscious, and medical assistance cannot be obtained within a 15-minute time interval. If an antidote must be administered, contact and receive instructions via telephone from a poison control center before administering if at all possible.

Disposal of Chemicals

Chemicals which can no longer be used in the instructional program should be removed from the school. Chemicals to be removed fall into three categories:

1. Hazardous chemicals — Those chemicals which pose greater risk than is acceptable. The nature of the hazard (carcinogen, explosive) should be indicated beside the name of the chemical.

2. Unneeded chemicals -- Chemicals which are not considered excessively hazardous but which are no longer used in the instructional program.

3. Useless chemicals -- Chemicals which are not excessively hazardous but which have been contaminated, aged, or otherwise rendered unusable as reagents.

Virginia science teachers have several options for disposal of chemicals.

1. Chemistry departments in local colleges and universities may accept chemicals from public schools. The instructional programs at these institutions may wish to safely make use of some hazardous chemicals or the college may agree to dispose of useless chemicals for a local public school.

2. Chemicals can be disposed of locally by using procedures outlined in MCA's *Laboratory Waste Disposal Manual.* Low hazard, useless chemicals are the best candidates for this option.

3. Local and state health departments may assist in finding a disposal method for hazardous chemicals.

4. Commercial disposal services are available.

5. Department of Education personnel will assist in the search for a viable disposal method. When in doubt as to how to dispose of a reagent, call for help.

Labeling of Chemicals

Proper labeling is fundamental to a safe and effective laboratory operation. Reagents created in the laboratory also require labeling.

Purchased materials usually have adequate identification of the material by chemical name. Reagents identified only by common name should also have individual chemical components listed on the label.

Precautionary statements are usually but not always included with flammables, corrosives, and reactive or explosive compounds.

ABSENCE OF PRECAUTIONS ON A MANUFACTURER'S LABEL DOES NOT MEAN THE MATERIAL HAS NO HAZARDS.

Everything that is not consumed within the class period in which it is made should be labeled. An unidentified reagent should be disposed of immediately.

Rules for making labels:

1. Indicate clearly, the working name, chemical name, and chemical formula of the reagent;

2. Indicate the name and address of the manufacturer;

3. Indicate the date the reagent was produced or purchased.

4. Indicate hazards and handling precautions.

SAMPLE LOCAL LABEL

Fehlings Solution B
(.68M $KNaC_4H_40_6.4H_2O$ 1.6M NAOH)
WARNING - Very Hazardous to Eye

CAUTION - Caustic - Poison

10/3/77

Prepared by G. Teacher

Lewis High Biology Department

Commercially available labels are spillproof, easy to use, and are relatively inexpensive. Pressure sensitive labels using the NFPA 704 hazard symbol space for additional information are preferred.

27

Chapter VI
BIOLOGICAL AND ENVIRONMENTAL HAZARD CONTROL

Biology, life science, and earth science teachers are confronted with a wide range of hazards. In addition to the hazards of chemical agents, are the hazards associated with (a) the handling of animals and micro-organisms, and (b) classroom activities on the school grounds and outdoor study areas. Effective control of such hazards involves (a) recognition of the hazard, (b) development of control procedures, and (c) the development of first-aid measures.

Laboratory Animals

A. Recognition of the hazard

Animals in the laboratory can be hazardous in several ways:

1. Approximately 120 animal diseases can be transmitted to humans;
2. Animals may contact and serve as carriers for human diseases;
3. Scratches and bites are hazards in the use of laboratory animals;
4. Animals can be sources of potentially severe allergies.

B. Control procedures

Purchasing considerations

1. Only certified disease-free animals should be purchased from reputable firms. The purchase of animals from local breeders or the use of pet animals is not advised.
2. Purchase only species suited to the learning environment and instructional program. Low food consumption and small physical size should be considered in the selection of an appropriate species.

Housing specifications

1. Animal care facilities should be of sufficient size to allow the animals to perform in relative comfort, such natural functions as eating, exercising, and sleeping. The facilities must be sanitary. Feeding and watering equipment should be selected for ease of cleaning and sanitizing and for suitability for the species. The facilities should be so designed as to

allow removal of animal waste with minimum disturbance to the animal.

2. Facilities should be provided for the isolation of unhealthy animals from other animals and students.

3. Climatic control (temperature, humidity, and air quality) must be sufficient to provide a humane environment for the laboratory animal.

Classroom management policies

1. The animals must be fed and their facilities cleaned at appropriate intervals. This schedule must be maintained on weekends and school holidays.

2. Cages, feeding devices, watering devices, and bedding materials should be sterilized.

3. Access to animal care facilities should be limited to those individuals directly responsible for the animals.

4. The appropriate climate for a species must be maintained at all times.

5. Animals suspected of being ill should be isolated.

6. People who are ill should not be permitted to handle and care for laboratory animals.

7. Appropriate protective equipment such as leather or rubber gloves should be worn when handling animals.

8. The dissection of wild or domestic specimens should be expressly forbidden.

C. First-aid procedures

Standard emergency procedures should be used. Any person bitten or scratched by an animal should receive medical attention. The wounds may be washed in cold water while arrangements are made for medical assistance. If the student should go into shock from animal bite or severe allergic reaction, standard first-aid procedures for shock should be followed.

Microorganisms

The primary hazards of working with microorganisms are (1) the contraction of an infectious disease, and (2) the infection of an open wound.

B. Control procedures

1. Use only sterile equipment.

2. Use appropriate handling procedures which will ensure that microorganisms are not released into the environment as aerosols.

3. Instruct students in appropriate procedures and supervise them to insure proper control of cultures.

4. Prohibit mouth pipetting.

5. Prohibit the culture of pathogenic microorganisms.

C. First aid

The use of microorganisms may result in infection of the exposed student. No specific first-aid measures are recommended. Emergency procedures should be implemented when an accident exposes a person to the microorganism.

*Blood Letting Experiments**

A. Recognition of the hazard

Experiments which involve the deliberate puncturing or cutting of human tissue may cause infection through the open wound and psychological damage to students whose moral or religious traditions are in conflict with this practice.

B. Control procedures

1. Inform parents of curriculum objectives requiring this practice.
2. Provide alternative experience for students who object to this practice.
3. Conduct the experiment in a sanitary facility.
4. Use an endorsed biology teacher or school nurse for the puncturing or cutting.
5. Thoroughly clean the area to be punctured with soap and water followed by isopropyl alcohol.
6. Use only sterile, disposable lancets.
7. Avoid contact of the punctured surface with any non-sterile surface.
8. Cleanse punctured area with alcohol after collection of blood sample.
9. Use sterile compress on wound until all bleeding stops.

C. First aid

First-aid procedures should include stopping bleeding and treating students who become nauseous or faint.

Field Study

A. Recognition of the hazard

Injuries due to (1) impact, (2) cuts and punctures, (3) poisoning, and (4) allergenic reactions are those most commonly encountered in field study activities.

B. Control procedures

1. A survey of the study area should be conducted by the instructor. The survey should include a list of all hazards including:

* Review student records to be sure to exempt hemophiliac students.

a. Conditions which may cause students to fall (steep terrain, slippery or unstable rocks);

b. Unstable objects overhead which may fall onto students;

c. Animal burrows or holes into which students could step;

d. Foot bridges or other elevated crossings which may collapse under student weight;

e. Deep water or stream with currents strong enough to sweep a student off balance;

f. Animals capable of attacking and injuring students;

g. Poisonous animals;

h. Ticks and chiggers;

i. Allergenic plants; and

j. Vehicle traffic.

2. Take precautionary measures such as:

a. Map the safest passage through the study area;

b. Determine that all students are physically capable of participating in the field study. (Heart condition, severe allergenic reactions, and ambulation difficulties must be considered);

c. Obtain permission from parents for children to be involved in studies off the school grounds;

d. Avoid areas which have been sprayed with herbicides or pesticides;

e. Use a school board approved means of transportation.

3. Instruct the students in:

a. Safe methods of personal and equipment transport over the study area;

b. Recognition and avoidance of poisonous plants and animals;

c. The use of appropriate foot gear and other clothing;

d. Safe methods of working on deep or treacherous bodies of water; and

e. The proper use of equipment including the wearing of eye protective devices.

4. Provide adequate supervision.

C. First aid

In addition to the laboratory emergency procedures, several special precautions should be taken.

1. A method for contacting the school office in an emergency should be specified.

2. Preparations should be made for special situations which may be present.

   a. If a student is known to have severe allergenic reactions, the appropriate antivenin should be carried.

   b. A local hospital or physician should be consulted for a recommended procedure for snake and spider bites.

   c. Be prepared to handle the accidental ingestion of poisonous plant matter in the same manner as a chemical poisoning.

   d. Provide appropriate means for transporting an injured student to a place accessible to motorized vehicles.

Chapter VII
OTHER HAZARDS AND CONTROL PROCEDURES

Fire

Fire hazards of chemical reagents are enumerated in Chapter V, **Chemical Hazard Control.** Fire is a pervasive hazard which cannot be limited to chemical reagents. Oversight, carelessness, and faulty apparatus are contributing factors to fires.

Fire Classification

The National Fire Protection Association (NFPA) classifies fires according to the characteristics of the combustible material present. Many fires will have a mixture of combustibles and have multiple classifications.

Class A — Ordinary combustible materials such as wood, paper, leaf litter, and cloth which are best extinguished with water. Foam and powder fire extinguishers can also be used.

Class B — Oil and other flammable liquids which can be extinguished with foam, powder, and carbon dioxide fire extinguishers. These combustibles cannot be extinguished with water.

Class C — Electrical fires caused by arcing in electrical equipment are best controlled with carbon dioxide or powder fire extinguishers.

Class D — Combustible metals such as magnesium and sodium which can be controlled by smothering in dry sand or by using a special Class D fire extinguisher.

Fire Prevention

The threat of fire can be reduced by controlling combustibles, oxidizers, and ignition sources.

1. Controlling combustibles:

   a. Limit the flammable and combustible chemicals in a work area to those actually being used;

   b. Limit laboratory work to a single class of flammables at a given time;

   c. Limit the accumulation of combustible materials such as paper, wood shavings, and clothing in storage areas;

d. Limit student access to areas where combustibles cannot be controlled. (Such areas would include areas where recent spillage of flammables has occurred, where combustible gas leaks are suspected, or where environmental conditions have increased the hazards of combustion as in woods and fields which have large amounts of dry litter.)

2. Controlling of oxidizers:

   a. Restrict access to air (the most frequently encountered oxidizer) by closing windows and doors to prevent drafting;

   b. Keep other oxidizing agents, such as chlorates and nitrates from coming into contact with combustible materials.

3. Controlling sources of ignition:

   a. Open flames should not be permitted near flammable liquids, combustible gases, or easily ignited combustibles;

   b. Electrical equipment should be kept free of sources of sparks or arcing and should be explosion proof;

   c. Other sources of ignition, lenses, parabolic mirrors, spontaneous combustibles, etc., should be separated from combustible substances.

Fire Control

Advance preparation is essential to controlling a fire. Monthly fire drills and periodic fire inspections must be conducted. In addition, the following precautionary measures should be taken:

1. All aisles and exits must be clear at all times;

2. Evacuation procedures should be clearly posted in each classroom;

3. ABC-rated portable fire extinguishers should be installed in each laboratory in accordance with NFPA-10-1975;

4. The extinguisher must be maintained at full charge, checked periodically, and serviced;

5. All students should be instructed in fire safety including the STOP, DROP, and ROLL techniques for clothing fires.

Emergency Procedures

If a fire starts:

1. Activate the fire alarm and evacuate the area;

2. Shut off (teacher only) the gas and electrical power to the laboratory using the master control switches;

3. Close all windows and doors, if possible;

4. Do not use a carbon dioxide or chemical fire extinguisher to put out hair or clothing fires;

5. Students with clothing fires should be pushed to the floor and rolled to extinguish the flames;

6. Treat for shock and give mouth to mouth resuscitation if a student is overcome by smoke;

7. A very small or localized fire may be controlled by a teacher using the fire extinguisher until all persons are evacuated, but leave the fighting of a full scale fire to professionals.

Radiation

Each year more equipment is brought into public school laboratories which previously was confined to universities or research laboratories. Much of this equipment brings new hazards.

1. Radioactive materials are considered a hazard (radiation poisoning) and can be controlled by:

   a. Insuring compliance with Nuclear Regulatory Commission regulations limiting schools to ten radioactive sources in quantitites small enough to be exempt from regulations;

   b. Maintaining the sources in sealed containers;

   c. Permitting student access to radioactive materials only under direct supervision of the instructor.

2. X-ray sources are a health hazard. Exposure to this type of radiation can be controlled by proper shielding on all devices using electron beams including cathode ray tubes, x-ray tubes, and television picture tubes. The use of any type of x-ray equipment on students should be expressly forbidden.

3. Ultra violet light sources can cause detachment of the retina in the eye and severe "sunburn." Control can be accomplished by shielding the student's eye from a direct or reflected source of ultra violet light. Skin must be shielded from intense sources of ultraviolet radiation such as may occur in arc welding.

4. Laser beams are capable of producing severe burns. Even the low-powered lasers can produce eye damage. To control the radiation hazards from lasers:

   a. Instruct all persons of the hazards;

   b. Post a sign on the entrance to the area whenever a laser is in use — "CAUTION LASER IN USE — Do not enter without permission of the instructor";

   c. Prohibit all activities which could contribute to direct viewing of the laser beam;

   d. Direct the wearing of "certified-for-use-with-laser" eye protective devices whenever a laser is producing radiation outside the visible region of the spectrum;

   e. Remove all reflective surfaces from the path of the beam;

   f. Terminate the laser beam in a non-reflective light-absorbing surface;

g. Prepare and test demonstrations without students present;

h. Reflect the beam only in a vertical plane;

i. Affix expanding lens rigidly to laser;

j. Block the beam whenever it is not in use;

k. Equip the laser with a key switch in the primary circuit;

l. Render the laser inoperable when not in authorized use;

m. Reduce optical power to the minimum necessary for use.

Model Rocketry

The construction and launching of rockets and the synthesis of fuels can be hazardous and should be discouraged for two reasons: (1) the potential for explosions and fires is high, and (2) there is the danger of being struck by a rocket or parts of the rocket during launch and free fall.

If model rockets are used, hazards can be controlled by:

1. Using only commercially available devices in controlled and supervised experiments;

2. Limiting power sources to compressed cold gases, cold liquids, or small prepackaged engines;

3. Insuring that rocket construction is durable enough to prevent breaking up in flight;

4. Equipping the rocket with an automatic parachute or other appropriate device for retarding descent to the ground;

5. Prohibiting the use of explosive or pyrotechnic materials in a rocket;

6. Designating a use area for rocket experimentation and prohibiting access by unauthorized personnel during experiments (this area must be large enough to permit safe recovery of the rocket under prevailing launch conditions and should not contain or be adjacent to high voltage power lines, major highways, multistory buildings, residential areas, etc.);

7. Construction of a sturdy explosive-resistant shield (wall, sandbags, or bunker) to protect students during launching and recovery;

8. Providing for launching by remote control.

In the event of injury to the student, standard emergency procedures (Chapter IV and V) should be invoked.

Co-Curricular Hazards

Home assignments, science projects, and other enrichment activities can be hazardous because there is little direct supervision by the teacher.

Control measures include:

1. Careful review by the teacher of the proposed activity to assess its hazard potential;

2. Make the student aware of hazards and safe procedures for control;

3. Arrange direct supervision by a qualified adult for activities which involve hazardous materials or equipment;

4. Prohibiting homework assignments involving the use of hazardous equipment or materials.

Student Errands

To control hazards to students doing errands:

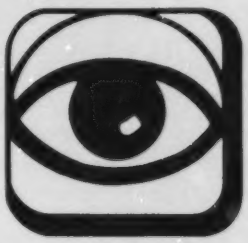
1. Prohibit the use of students to run errands off school grounds;

2. Prohibit the use of students to transport hazardous chemicals and equipment when not under direct supervision of a responsible adult;

3. Prohibit unsupervised student access to hazardous areas such as construction sites, maintenance storerooms, and unlighted corridors;

4. Assess the emotional and physical maturity of the student prior to assigning an errand.

Chapter VIII
EYE AND FACE PROTECTION



The vulnerability of the human eye to injury and its inability to recover as rapidly or as completely as other body tissues warrants special consideration for eye protection. The Commonwealth of Virginia has enacted a variation of a model law developed by the National Society for the Prevention of Blindness. The Act of the General Assembly of Virginia (Section 22-10.2) requires the wearing of eye-protective devices at all times while participating in designated school activities. The law is as follows:

22-10.2 Protective Eye Devices. Every student and teacher in any school, college, or university participating in any of the following courses:

(A) Vocational or industrial arts shops or laboratories involving experience with:

1. Hot molten metals;
2. Milling, sawing, turning, shaping, cutting, grinding, or stamping of any solid materials;
3. Heat treatment, tempering, or kiln firing of any metal or other materials;
4. Gas or electric arc welding;
5. Repair of any vehicle;
6. Caustic or explosive materials.

(B) Chemical or combined chemical-physical laboratories involving caustic or explosive chemicals or hot liquids or solids; shall be required to wear industrial quality eye protective devices at all times while participating in such courses or laboratories.

The governing board of authority of any public or private school or the governing body of each institution shall furnish the eye protective devices prescribed in this section free of charge or at cost to the students and teachers of the school participating in the courses set out in this section; provided, however, that such devices shall be furnished to all visitors to such courses.

"Industrial quality eye protective devices", as used in this section, means devices providing side protection and meeting the standards of the American Standards Association Safety Code for Head, Eye, and Respiratory Protection, z2.1-1959, promulgated by the American Standards Association, Inc. (1966, c.69.)

As of July 1977, similar laws have been enacted in thirty-six states.

Eye-Protective Devices

There are several styles of eye-protective devices which meet the American National Standards Institute (ANSI) Standards z87.1-1968. This standard supercedes ANSI Standards z2.1-1959 specified in the eye protection law. Any eye-protective device which meets this standard and provides side shields should provide adequate protection from impact hazards. Additional protection is recommended for chemicals and radiation.

1. When working with caustic or corrosive liquids, gases, vapors, or aerosols, splash resistant chemical goggles that meet Standard z87.1 1968 are recommended. Face shields are also recommended when large amounts of these substances may be splashed.

2. Eye-protective devices certified for control of specific wavelengths of hazardous radiation are recommended.

Eyewash Fountains

An eyewash fountain should be available as a backup system to eye-protective devices. This device should be available for immediate flushing of the eye should a chemical splash occur. Two arrangements are suggested.

1. A permanently installed basin using twin streams of water to gently wash the eyes which may be operated by hand, foot, or by pushing a bar with the head.

2. A 5-foot length of ½ inch rubber hose with an aerated nozzle attached to a working sink faucet and stored in a manner to prevent chemical contamination.

An eyewash device should be available in every science laboratory where chemicals are used. A chemical splash of a strong caustic chemical must be flushed within 10-30 seconds to avoid visual impairment.

Eyewash stations consisting of a wall holder and a bottle containing boric acid or a buffer solution are of doubtful value and should not be used.

Management Procedures

The key to effective control of eye hazards is a management system based upon carefully developed policies. Such policies should be incorporated into the overall safety plan and included in the school policy manual.

Example

1. Eye-protective devices shall be furnished and worn in accordance with Section 22-10.2 of *Virginia School Laws.*

   a. The eye-protective devices shall meet American National Standards Institute Standard z87.1 1968.

   b. The eye-protective devices should provide protection against all eye hazards to be encountered.

      (1) Splash-resistant goggles shall be worn in all laboratories using corrosive or caustic liquids or vapors.

(2) Goggles certified for use with specific wave-lengths of potentially hazardous radiation shall be worn in laboratories using such radiation.

2. Eye-protective devices shall be worn at all times by all persons in a laboratory area.

   a. Specific areas should be designated for the wearing of eye-protective devices.

   b. All persons including the instructor and visitors shall be issued and required to wear eye-protective devices prior to entering this area.

   c. Eye-protective devices shall be worn over corrective lenses.

3. Contact lens should be discouraged for use in a laboratory.

   a. Students and parents should be instructed thoroughly in the additional hazards posed by contact lens in a laboratory.

   b. Splash-resistant chemical goggles shall be worn whenever contact lens are permitted in a laboratory area.

   c. A procedure for removal of contact lens from the eye of an injured student must be developed and tested.

4. An eyewash device shall be readily available and operable.

5. An emergency drill should be developed and implemented to familiarize all students with emergency procedures for eye injuries prior to activities involving eye hazards.

6. All students shall be thoroughly instructed in the specific hazards to be encountered in a designated activity and in safe procedures for conducting the activity.

7. The classroom shall be supervised in such a manner as to eliminate eye hazards resulting from student misconduct.

Chapter IX
DOCUMENTATION

Several forms of documentation are recommended to insure maximum safety awareness on the part of the instructor and the students. Such documentation should enable teachers and supervisors to assess potential hazards in the instructional program and to determine probable cause if an accident occurs. The recommended documents are inventories, personal protective equipment records, equipment and maintenance records, accident reports, safety instruction records, and fire extinguisher records.

Inventories

All equipment, chemicals, and supplies should be inventoried at least once a year. Such inventories allow rapid assessment of hazards, document the need for supportive materials, and identify obsolete or otherwise useless equipment and supplies. Inventories useful in the science instructional program are discussed in more detail in Chapter II, "Assessing Needs".

Personal Protective Equipment Records

Written records should be kept of personal protective equipment which include;

1. The name, amount, date acquired, and storage location for personal protective equipment;
2. Name of student and date of issue;
3. Date and condition of equipment when returned;
4. Date of repair or replacement of faulty equipment;
5. Date of sterilization of equipment.

Equipment Maintenance Records

All equipment should be inspected monthly and certified as being in safe operating condition. Inoperable and unsafe equipment must not be used until repairs are made. Equipment which breaks down in operation should be withdrawn from use. Equipment repair and maintenance records should include:

1. Name and serial number of equipment;
2. Supplier and date acquired;
3. Dates of inspection;
4. Date reported inoperable and withdrawn from service;
5. Description of malfunctions;
6. Date and copies of repair requests;
7. Date repaired and returned to service.

Accident Reports

An accident report should be completed and filed in the school records immediately following an accident. The report should contain the following information:

1. Name of supervising teacher;
2. Name(s) of injured student(s);
3. Date and time of accident;
4. Location;
5. Description of activity in which student was injured;
6. Description of accident;
7. Emergency procedures administered;
8. Statements of witnesses to the accident.

Exhibit I (p. 36) illustrates a recommended accident report form.

Safety Instruction Records

Written lesson plans which include the safety instructions given to a specific class can be used to document instruction.

Parent, student, and teacher agreements on student conduct and responsibilities are recommended. A code of conduct should be formulated similar to that required by the "Standards of Quality for Public Schools in Virginia," but which deals specifically with safe conduct. These should serve to make parents and students aware that hazards exist in a science laboratory and that specific precautions are to be taken. It is suggested that both the parent and student sign a copy of the agreement. Exhibit II (p. 37) illustrates two examples of this type of agreement.

Permission of the parent for a student to engage in off-ground activities should be secured prior to undertaking this type of instruction. Permission slips should indicate the nature and location of the activity, method of transportation, time of departure and return, supervision to be provided, and any special precautions to be taken by the parent.

Fire Extinguisher Records

Fire extinguishers must be readily available in science laboratories. They must be operable. A periodic program of inspection, maintenance, and repair should be implemented. Fire extinguisher records should list extinguishers by type, location, size, and date on which the extinguisher is certified to be usable.

EXHIBIT I

SUGGESTED ACCIDENT REPORT FORM

Name of Supervising Teacher _____

Date Filed: _____

1. Accident Occured

   Date _____ Time _____

   Location _____

2. Name and Address of Injured _____

   _____

3. Nature of Injury _____

4. Description of Accident (Include brief description of activity in which injured party was engaged) _____

   _____

   _____

5. Witness (Name and association with injured — lab partner, etc.)

   _____

6. First-aid or Emergency Procedure Taken _____

   _____

7. Notification of Parent or Guardian (Indicate person notified)

   _____

8. Type of Medical Attention Received _____

   Emergency Room _____

   School Nurse _____

   Private Physician (Name) _____

EXHIBIT II

PARENT-STUDENT SAFETY CONTRACT

Students will be removed from the science activity area by the teacher if:

a. Their personal appearance or dress is such that they can cause injury to themselves or to other students;

b. They are behaving in such a manner that they can cause injury to themselves or to other students;

c. They are not following the prescribed safety rules for the laboratory or the particular science activity being conducted;

d. They are going beyond the limits of the science activity into areas that may lead to an unsafe situation;

e. They have not completed the pre-experiment activities which will allow them to work safely in the laboratory situation.

I, _____ (student) _____ , have read and understand the above rules.

I, _____ (parent) _____ , have read the above rules. I have discussed them with my child and feel that my child understands them. I would like to inform the school that my child has the following physical or medical conditions which could affect his/her learning in a science class.

1. _____

2. _____

3. _____

4. _____

_____ _____

Home Phone Number Business Phone Number

I, _____ (teacher) _____ , have received a copy of this form from _____ (student's name) _____ on _____ (date) _____. A copy of this agreement was given to the student and a copy put in my files

I agree to:

1. Follow instructions explicitly;
2. Perform only authorized experiments;
3. Protect eye, face, hands, body, and long hair;
4. Practice good housekeeping;
5. Get help fast from predetermined sources;
6. Know location of first-aid and fire-fighting equipment;
7. Report at once all accidents and unusual occurrences;
8. Never "horse around";
9. Ask questions if I don't understand what to do.

I understand the need for safe attitudes and behavior in the laboratory. Safe practices are for the protection of myself and others. I agree to act within the limits of the posted rules.

Student Name _____

Parent Name _____

Teacher Name _____

Date _____

Chapter X
DESIGNING FOR SAFETY

The teacher and the principal have the major responsibility for insuring the safety of the students entrusted to them. Sound management and instructional practices constitute the major portion of an effective safety program. The design of the instructional space dictates to some extent the instructional program which may be carried out therein. Some activities cannot be implemented unless specific safety equipment is available. In the following suggestions for laboratory design, three assumptions have been made concerning instructional care:

1. Each laboratory is a working area aimed at providing students with actual experience in scientific activities;

2. Each area must be sufficiently flexible to accommodate future, as well as present instructional needs;

3. Where flexibility is at variance with safety, the safety considerations must predominate.

Laboratory Construction

There are many appropriate laboratory designs. The design should be conducive to instruction in the science programs that will be implemented in the facility. The design should also have the flexibility to accommodate several types of science programs or changes in science programs.

Specific Recommendations

1. Each laboratory unit should have two (2) exits not adjacent to each other. Exits into adjoining classrooms and where usable, windows may be counted. (National Fire Protection Association 45-1975 and Virginia Occupational Safety and Health Standards for General Industry 1977).

2. The laboratory should be designed for a maximum number of students. The occupant load should be determined by the number of designated student laboratory stations installed.

3. All electrical installations should be in conformance with the provisions of the national electrical code (NFPA-70-1975). Electrical outlets on work surfaces where spillage of conducting fluids is expected should be considered extra-hazardous.

4. Provisions should be made to protect gas, water, and electrical outlets from vandalism by

students. These services should be available only to students participating in laboratory activities. Students in lecture sections, assigned reading, or other classroom activities should have seating and work surfaces at a distance greater than arms length from these services.

5. Work surfaces where caustic or corrosive materials are to be used should be standing height of 36 inches (92 cm).

6. Ventilation for all laboratories shall be provided in conformance with NFPA-45-1975. Laboratories without conventional windows should have a source of "make-up air."* Laboratory air should not be recirculated to other parts of the building by the heating or air conditioning system.

7. Fume hoods should be installed in all laboratories where flammable or toxic vapors or airborne particulates are generated (NFPA 45-1975). A face velocity of 100 fpm is recommended. Since hoods are routinely used for potentially explosive mixtures of flammable vapors and air, all electrical connections such as switches, lights, and motors should be explosion proof. All hood controls should be located outside the vented area. Sufficient "make-up air" must be provided for hood operation.

8. The laboratory should be designed and constructed in such a manner as to permit use by handicapped persons. (Section 503-504 of the Rehabilitation Act of 1973). The following specific recommendations are from *Creating an Accessible Campus,* Association of Physical Plant Administrators of Universities and Colleges, 11 Dupont Circle, Suite 250, Washington, DC 20036;

   a. Work surface 30 inches (76 cm) high with adjustable height preferred;

   b. Under-counter space 29 inches (74 cm) high, 20 inches (50 cm) deep, and 36 inches (92 cm) wide;

   c. Service outlets within arms reach of seated student;

   d. Aisle widths of 42-48 inches (107-122 cm) between handicapped station(s) and exits;

   e. Work surface where corrosive or caustic liquids are used should have lip or retaining edge to contain such spills.

9. The layout should be such that a 54 inch (137 cm) aisle exists between work stations where students must work back-to-back. All other corridors between stations should be a minimum of 40 inches (102 cm).

Storage Space

Storage space should be provided to insure that all equipment, chemicals, and other teaching supplies can be secured against unauthorized use. In-room storage should be installed in such a manner as not to hamper student movement to work stations or exits (NFPA 45-1975).

---

* Make-up Air — Volume of air drawn into the designated space at the same rate as air is removed from the space by positive ventilation.

Special Storage Considerations

Chemical storage in a school building should serve three functions:

1. Provide security against unauthorized use;
2. Restrict or vent emissions from stored chemicals;
3. Protect the chemicals from fire.

Special Recommendations

1. All storage areas that contain materials which are poisonous, corrosive, caustic, or explosive must be provided with a jimmy-resistant lock system. This would include all chemicals rated 2, 3, or 4 on either health, reactivity, or flammability.
2. Flammable storage cabinets should be constructed in accordance with the requirements of NFPA 30-1973. Such cabinets should be vented to the outside of the school building.
3. High school laboratory suites should have a storage room constructed and ventilated in accordance with NFPA 30-1973. The floors in such storage rooms should be constructed of chemical resistant material and form a liquid-tight catch basin. The storeroom should be equipped with an exhaust system capable of six changes of room air per hour. All electrical connections such as lights, switches, and motors should be explosion proof.

Safety Equipment

Safety equipment should be provided to reduce the potential for accidental injury. The provision of such equipment should depend on the probability of an accident occurring. The risk of having a person splashed with a concentrated acid is very high in a chemistry lab and low in a physics lab under normal operating conditions.

1. Portable fire extinguishers (ABC rated) should be located, installed, and maintained in accordance with the "Standards for the Installation of Portable Fire Extinguishers," NFPA 10-1975 and PAR 1910:157 Sub Part L of the *Virginia Occupational Safety and Health Standards for General Industry, 1977.*
2. Eyewash fountains are recommended for all laboratories. These should be capable of providing a steady low pressure (25 psi) flow of water for a minimum of 15 minutes.
3. Master controls should be provided for gas, water, and electricity. In the event of fire, electrical shock, flooding, or explosion, the teacher should be able to shut down the services and initiate emergency procedures.
4. Safety shower(s) should be provided where strong caustics, corrosives, or skin-absorbable poisons are utilized in the program. Most chemistry programs would be in this category. NIOSH "Safety in the School Science Laboratory" recommends the following specifications for safety showers:
   a. Showers should be located no further than 50 feet (15 m) from work stations where corrosives and caustics are being used and preferably no more than 25 feet (7.6 m) from point of egress;

b. Showers should be located away from electrical apparatus, power outlets, or panels;

c. Shower locations should be indicated by a painted circle or square on the floor;

d. Shower heads should be located 7-8 feet (2-2.5 m) above the floor and a minimum of 25 inches from the nearest wall;

e. A floor drain for the showers is recommended;

f. The shower valve should be operated by a ring and chain, triangle, and rod or chain arrangement;

g. The shower flow rate should be between 30 and 60 gallons per minute (100-200 l) with a pressure of 20 to 50 psi.

REFERENCES

Armitage, Phillip and Johnson Fasemore. *Laboratory Safety.* Heinemann Educational Books, London, 1977.

Crunkilton, John R. and Stephen T. Grant. *Student Injury and Teacher Liability.* Division of Vocational and Technical Education, Virginia Polytechnic Institute and State University, Blacksburg, Va., 1978.

"Fire Protection for Laboratories Using Chemicals." (NFPA 45-1975) National Fire Protection Association, 470 Atlantic Ave., Boston, Mass., 02210.

Fisher Safety Manual. Fisher Scientific Company, 711 Forber Ave., Pittsburgh, Pa., 15219.

Lab Safety at the Center for Disease Control. U.S. Department of Health, Education, and Welfare. DHEW Publication 20. Washington, D.C. 26-8118.

Merck Index. Merck and Company, Inc., Rahway, N.Y.

Safety in the Academic Chemistry Laboratories. American Chemical Society, 1974.

Safety in the School Science Laboratory. NIOSH, Division of Training and Manpower Development, Cincinnati, Ohio 35226.

Science Safety Series. Division of Instruction, Oakland Schools, 2100 Pontiac Rd., Pontiac, Mich. 88054, 1977.

Steere, Norman V. (Editor). *Safety in the Chemical Laboratory.* American Chemical Society, Eastern Pennsylvania 18042, 1974.

STOP: Safety First in Science Teaching. North Carolina Department of Public Instruction, Raleigh, N.C. 27611, 1977.

Virkus, Robert N. *Safety in the Secondary Science Classroom.* National Science Teachers Association, 1742 Connecticut Ave., N.W., Washington, D.C. 20009, 1978.

APPENDICES

APPENDIX A

CHEMICAL HAZARDS

The listed chemical substances were evaluated by the Bureau of Toxic Substances Information of the Virginia Department of Health. The list was derived from a limited sample of public school inventories. It is not inclusive of all potential chemical hazards but is intended to acquaint teachers and administrators with a sample of known chemical hazards. School personnel are expected to protect students from these hazards through proper handling, usage, and storing of these chemicals. If appropriate facilities and equipment do not exist to safely use such chemicals, the Science Service advises that said chemicals be removed from the school. It is also strongly advised that all positive carcinogens be removed.

GROUP A — POSITIVE CARCINOGENS

Anthracene: carcinogen of skin

Asbestos: positive human carcinogen

Ascarite: positive human carcinogen

GROUP B — SUSPECTED CARCINOGENS

Acetamide: positive animal carcinogen

Acrylonitrile: possible carcinogen; toxic by inhalation and skin absorption; severe skin and eye irritants; FLAMMABLE

Ammonium Chromate: possible carcinogen; positive teratogen in mice; POISON; oral human lethal dose (LDLo) 5 mg/kg

Arsenic Trioxide: suspected human carcinogen; POISON either by dust inhalation or ingestion LD_{50}1430 ug/kg

Benzene: suspected human carcinogen; possible teratogen; TOXIC to central nervous system TDLo 130 mg/kg

Benzone: possible carcinogen and teratogen

Cadmium: possible animal carcinogen — POISON inhalation of dusts or fumes TCLo 88 ug/m^3 soluble compounds highly toxic by ingestion

Cadmium Chloride: positive animal carcinogen

Cadmium Sulfate: positive animal carcinogen and teratogen; POISON inhalation human TCLo 20 ppm; oral human 43 mg/kg; toxic to central nervous system, known to cause liver and kidney damage in humans

Chloroform: suspected animal carcinogen and teratogen; POISON; oral LDLo 140 mg/kg, inhalation TCLo 10 ppm; affect heart muscle, liver, and kidneys

Chromium: suspected carcinogen; hexavalent compounds can cause skin ulcers and dermatitoxic by inhalation TCLo 4500 ug/m^3 OSHA std air-TWA 1 mg/m^3

Chromium III Oxide: suspected animal carcinogen

Chromium IV Oxide: (chromium trioxide) suspected carcinogen, mutagen, teratogen

Cobalt: suspected carcinogen

Colchicine: possible animal carcinogen, mutagen, teratogen, POISON; 0.02 gm may be fatal if ingested

1.2 Dichloroethane: possible carcinogen; POISON; inhalation TCLo 4000 ppm/hour; oral TDLo 428 mg/kg

p-Dioxane: possible animal carcinogen; POISON; affects liver and kidneys; inhalation TCLo 470 ppm, oral 500 mg/kg; may form EXPLOSIVE peroxides

Diphenyl Ester Carbonic Acid: suspected animal carcinogen

Lead Arsenate: (arsenic acid, lead (2+) salt): positive animal carcinogen; POISON; oral LDLo 10 mg/kg

Lead Chromate VI: possible carcinogen; toxic by inhalation and ingestion

Methyl Iodide: positive animal carcinogen; TOXIC oral LDLo 50 mg/kg; skin absorption 1 gm/10 meter

Nickel: positive animal carcinogen; allergen; FLAMMABLE

Nickel II Acetate: animal carcinogen

Nickel Carbonate: suspected carcinogen

Nickel II Oxide: suspected animal carcinogen

Phenol: suspected carcinogen; POISON; oral LDLo 140 mg/kg; strong tissue irritant readily absorbed through skin

Potassium Chromate: suspected animal carcinogen

Salenium: suspected carcinogen; POISON; toxicity similar to arsenic (toxicity for arsenic not given)

Sodium Arsenate: suspected animal carcinogen and teratogen; POISON; oral LDLo 5 mg/kg

Sodium Arsenite: suspected human carcinogen; POISON, oral LDLo 5 mg/kg

Sodium Nitrite: potential carcinogen; TOXIC LDLo 50 mg/kg; Oxidize-forms EXPLOSIVE mixture with organic compounds

Stearic Acid: potential carcinogen (skin)

Sudan IV: positive animal carcinogen

Tannic Acid: positive animal carcinogen

Thioacetamide: positive animal carcinogen

Thiourea: positive animal carcinogen

O-Toluidine: suspected human carcinogen; dermal absorption

Trichloroethylene: suspected animal carcinogen; TOXIC to central nervous system; inhalation TCLo 160 ppm

Uranium: suspected carcinogen; radioactive; fire hazard; ignites spontaneously in air

Uranyl Acetate: suspected carcinogen

Uranyl Nitrate: suspected carcinogen; EXPLOSIVE; severe fire and explosion risk in contact with organic compounds; TOXIC

Urethane: suspected carcinogen and mutagen

Vinylite: possible carcinogen

GROUP C— HIGHLY TOXIC (POISONS)

Aluminum Chloride: (anhydrous) strong skin irritant; reacts violently with water to give HCL

Ammonium Bichromate: allergen (inhalation of dust can cause asthmatic symptoms; skin and eye irritant; OXIDIZER; fire hazard; forms EXPLOSIVE mixtures with organic compounds

Ammonium Vanadate: TOXIC; oral LDLo 18 mg/kg

Aniline: TOXIC; affects central nervous system; oral LDLo 50 mg/kg; allergen; may cause contact dermatitis

Aniline Hydrochloride: same toxicity as aniline

Antimony: TOXIC; inhalation TCLo 4700 ug/m^3; antimony compounds irritant to skin and mucous membranes

Antimony Chloride: TOXIC and CORROSIVE, strong irritant to eyes and skin; TDLo 73 mg/kg inhalation

Antimony Oxide: TOXIC LDLo 2 mg/kg; may cause dermatitis

Antimony Potassium Tartrate: TOXIC; oral LDLo 2 mg/kg

Arsenic Chloride: poisonous as arsenic; strong irritant to eyes and skin (toxicity of arsenic is NOT indicated)

Arsenic Pentoxide: POISON LDLo 5 mg/kg

Barium Compounds: All barium compounds are TOXIC by ingestion and are also skin irritants

Barium Chloride: oral LDLo 11.4 mg/kg

Benzoyl Peroxide: TOXIC-pulmonary system; LDLo 500 mg/kg. FLAMMABLE; EXPLOSIVE; may explode spontaneously when dry

Beryllium Carbonate: highly TOXIC by inhalation and ingestion

Bromine: severe skin irritant; CORROSIVE; TOXIC; oral LDLo 14 mg/kg; inhalation LDLo; 100 ppm; OXIDIZER; forms EXPLOSIVE mixtures with organic compounds

Butanol: TOXIC; irritant to skin and eyes; TCLo 25 ppm

Cadmium Compounds: highly TOXIC by inhalation of dust or fumes; soluble compound highly TOXIC by ingestion

Calcium Cyanide: highly TOXIC; decomposes in moist air, water, and weak acids to form hydrogen cyanide; LDLo 5 mg/kg

Catechol (pyrocatechol): TOXIC LDLo 50 mg/kg; allergen; threshold limit value — air 1 ppm

Chloral Hydrate: TOXIC; affects central nervous system LDLo 4 mg/kg; liquid and vapor dangerous to eyes

Chlorobutanol (chloretone)

Chloretone (chlorobutanol): TOXIC LDLo 50 mg/kg; affects central nervous system

Chlorpromazine: TOXIC; affects central nervous system; LDLo 50 mg/kg

Chromic Acid: corrosive to skin; FIRE HAZARD: OXIDIZER, forms explosive mixtures with organic compounds

n,n-Dimethylaniline: TOXIC; depressant of central nervous system; absorbed through skin; LDLo 50 mg/kg; maximum tolerance to air 5 ppm

2,4-Dinitrophenol: highly TOXIC; absorbed by skin; may cause dermatitis and liver damage; dust inhalation can be fatal; LDLo 36 mg/kg. EXPLOSIVE

Ethylene Oxide: TOXIC; cause hypersensitivity and skin irritation, Mutagenic; inhalation TCLo 30 mg/m^3; FIRE HAZARD

Ether: strong narcotic; FLAMMABLE: EXPLOSIVE due to peroxide formation

Formaldehyde: (gas) highly toxic; strong irritant TCLo 13.8 ppm; in solution; toxic through breathing vapor and skin contact

Hexachlorophene: TOXIC to central nervous system LDLo 50 mg/kg

Hydrobromic Acid: TOXIC; CORROSIVE; irritant; TCLo 3 ppm; reacts with water to produce toxic and corrosive fumes

Hydrofluoric acid: TOXIC; irritant; corrosive TCLo 50 ppm

Hydrogen sulfide: strong irritant and asphyxiant LCLo 600 ppm; FLAMMABLE

Hydroquinone: irritant; allergen; LDLo 29 mg/kg

Iodine Crystals: highly TOXIC by ingestion and inhalation; strong irritant to eyes and skin; LDLo 2000 mg/kg

Lead Compounds: highly TOXIC by ingestion and inhalation

Magnesium Chlorate: TOXIC; LDLo 50 mg/kg; OXIDIZER; forms flammable and explosive mixture with organic compounds

Mercury: TOXIC by ingestion, inhalation and skin absorption; applies to all mercury compounds

Mexitylene: TOXIC; LDLo 50 mg/kg

Nicotine: POISON; LDLo 1 mg/kg; can be absorbed by skin

Oxmium Tetroxide: TOXIC; strong eye and mucuous membrane irritant; TCLo o.1 mg/m^3

Paris Green: (bis(aceto) hexametaarsenitotetra copper); POISON; LDLo 5 mg/kg

1-Phenyl-2-Thiourea: TOXIC; rat LD_{50} 3 mg/kg

Phthalic Anhydride: skin irritant

Potassium Oxalate: TOXIC by inhalation and ingestion; CORROSIVE

Pyrogallic Acid: TOXIC by ingestion and skin absorption; LDLo 50 mg/kg

Phenyl Salicylate (salol): TOXIC; LDLo 50 mg/kg

Silver Cyanide: highly TOXIC by ingestion and inhalation

Silver Nitrate: highly TOXIC and strong irritant to skin and tissue

Sodium Azide: TOXIC; LDLo 5 mg/kg; EXPLOSIVE

Sodium Fluoride: TOXIC to central nervous system; LDLo 75 mg/kg

Sodium Permanganate: TOXIC; TDLo 2400 ug/kg; OXIDIZER; forms FLAMMABLE and EXPLOSIVE mixtures with organic compounds

Sodium Silicofluoride: strong tissue irritant; TDLo 2400 ug/kg

Sodium Sulfide: TOXIC; strong tissue and skin irritant; LDLo 50 mg/kg; FIRE HAZARD

Sodium Thiocyanate: TOXIC; LDLo 50 mg/kg

Stannic Chloride: CORROSIVE, yields hydrochloric acid on heating

Sulfuric Acid (fuming): highly TOXIC, strong irritant to tissue; reacts violently with water

Tetrabromoethane: TOXIC: irritant by inhalation

Toluene: TOXIC to central nervous system; TCLo 100 ppm; FLAMMABLE; forms EXPLOSIVE mixture with air

GROUP D — EXPLOSIVES AND FLAMMABLES

These chemical reagents require special precautions in handling usage and storage

Ammonium Dichromate: OXIDIZER; forms explosive mixtures with organic materials; toxic (see Group C)

Aniline: moderate FIRE HAZARD; toxic (see Group C)

Benzoyl Peroxide: FLAMMABLE; EXPLOSIVE: may explode SPONTANEOUSLY when dry; TOXIC (see Group C)

Bromine: OXIDIZER; FIRE HAZARD or EXPLOSIVE when in contact with organic compounds; TOXIC (See Group C)

Chromic Acid: OXIDIZER; FIRE HAZARD; forms explosive mixture in contact with organic materials

Cyclohexane: FIRE HAZARD

Cyclohexene: FIRE HAZARD

2,4-Dinitrophenol: EXPLOSIVE; severity increases with drying; TOXIC (see Group C)

Ethylene Oxide: FIRE HAZARD; TOXIC (see Group C)

Ether: FLAMMABLE; forms explosive mixture with air, EXPLOSIVE due to formation of peroxides with aging; TOXIC (see Group C)

Gasoline: FLAMMABLE; forms explosive mixture with air

Gunpowder: EXPLOSIVE

Hydrogen Sulfide: FLAMMABLE gas; TOXIC (see Group C)

Lithium: FIRE HAZARD; severe explosion risk (reactivity) with water, nitrogen, acids or oxidizers

Magnesium: FIRE HAZARD

Magnesium Chlorate: OXIDIZER; dangerous fire risk in contact with organic materials; TOXIC (see Group C)

Mercuric Nitrate: OXIDIZER; forms flammable and explosive mixtures with organic materials; TOXIC (see Group C)

Methyl Ethyl Ketone: FLAMMABLE; forms explosive mixture with air; TOXIC (see Group C)

Methyl Methacrylate: FLAMMABLE; forms explosive mixture with air; TOXIC (See Group C)

Pentane: FLAMMABLE; forms explosive mixture with air; TOXIC

Perchloric Acid: OXIDIZER; severe explosion hazard in contact with organic materials; VERY DANGEROUS

Petroleum Ether: FLAMMABLE; forms explosive mixture with air; TOXIC (see Group C)

Phosphorus (red): FLAMMABLE; moderate explosive; reacts with oxygen and water to generate phosphine (which is highly toxic by inhalation); (white): FLAMMABLE and POISON; LDLo 1400 ug/kg; ignites spontaneously; must be stored under water

Phosphorus Pentoxide: FIRE HAZARD; reacts violently with water

Picric Acid: EXPLOSIVE; more powerful than closely related TNT, TOXIC (see Group C)

Potassium: FIRE HAZARD: can ignite spontaneously with air; violent reaction with water; OXIDIZER; forms explosive peroxides while aging and can explode when handled or cut; must be stored under liquid hydrocarbons

Potassium Chlorate: OXIDIZER; forms explosive mixture with organic compounds; TOXIC

Potassium Periodate: OXIDIZER; FIRE HAZARD in contact with organic materials

Potassium Permanganate: OXIDIZER; forms flammable and explosive mixtures with organic compounds; ignites spontaneously on contact with glycerine or ethylene glycol; TOXIC

Potassium Sulfide: FIRE HAZARD; which may ignite spontaneously; EXPLOSIVE as dust or powder; POISON; LDLo 50 mg/kg

Pyridine: FLAMMABLE; forms explosive mixture with air; TOXIC; LCLo 500 mg/kg

Silver Oxide: OXIDIZER; forms flammable and explosive mixtures with organic materials or ammonia; moderately TOXIC

Sodium: FLAMMABLE solid; violent reaction with water; severe caustic irritant to tissue; must be stored under liquid hydrocarbons

Sodium Azide: EXPLOSIVE (HEAT SENSITIVE) POISON

Sodium Chlorate: OXIDIZER; forms flammable explosive mixtures with organic compounds

Sodium Permanganate: OXIDIZER; forms flammable explosive mixture with organic compounds; TOXIC (see Group C)

Sodium Sulfide: Unstable compound; FIRE HAZARD; TOXIC (see Group C)

Strontium: SPONTANEOUSLY FLAMMABLE with air; store under naphtha

Strontium Nitrate: OXIDIZER; forms flammable explosive mixture with organic compounds

Thermite and related compounds (mixture of iron oxide and powdered aluminum): FIRE HAZARD; once used for incendiary bombs

Titanium Trichloride: OXIDIZER: forms flammable mixture with organic materials; TOXIC

Toluene: FLAMMABLE; forms explosive mixture with air; TOXIC (see Group C)

2,2,4-Trimenthylpentane: FLAMMABLE; forms explosive mixture with air; moderately TOXIC by inhalation and ingestion

Explanation of Toxicity:

LCLo — lowest published lethal concentration. This is the lowest known concentration to kill. It will usually be given in parts per million (ppm) or in milligrams (mg) or micrograms (ug) per cubic meter (m^3) of air.

LDLo — lowest published lethal dose is the smallest dose known to cause death. It is given in grams (g), milligrams (mg) or micrograms (ug) per kilogram (kg) of body weight.

LD_{50} — Lethal dose for 50% of the treated population.

APPENDIX B

NEWS RELEASE
NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

CONTACT: Dennis Hirschfelder

NSPB ANNOUNCES STAND ON CONTACT LENS USE IN INDUSTRY

The National Society to Prevent Blindness cautions against the wearing of contact lenses at work by industrial employees. An estimated 800,000 individuals in the United States are fitted with contact lenses each year, added to the more than nine million Americans who already wear them. Many of these individuals are employed in industry; a great many others will accept such work in the future. Thus the significance and possible effects of an industrial environment on the eyesight of workers who wear contact lenses on the job are of particular concern to the Society.

The National Society and its Advisory Committee on Industrial Eye Health and Safety has issued the following statements:

"Because of increased risk to the eyes, the National Society to Prevent Blindness strongly advises that the use of contact lenses of any type by industrial employees while at work should be prohibited, except in rare cases. The National Society recommends that any exceptions be verified in writing to the employer by the physician or optometrist who sanctions such use in a specific industrial environment. Contact lenses do not provide eye protection in the industrial sense; their use without eye and/or face protection devices of industrial quality* should not be permitted.

* "To be of industrial quality, safety eyewear devices must meet or exceed *all* requirements of the *American National Standard Practice for Occupational and Educational Eye and Face Protection, Z87.1-1979,* or later revisions thereof, as published by the American National Standards Institute, Inc."

In support of its advisory statement on occupational use of contact lenses, the NSPB raised several points which it believes industrial management, safety engineers, and other concerned or responsible specialists should carefully consider.

Small and medium-sized industrial firms, which constitute the majority of American industry, normally function without in-plant medical direction and control, and often lack nursing services except for the day work shift. Under such adverse conditions, even the problem of removing an accident victim's contact lenses assumes serious proportions. Delay in removing such lenses, especially when chemicals have been splashed into the eyes, can negate the recommended copious flushing of the eyes with water.

In dusty environments, small foreign particles and fine particulate matter which normally would be washed away by tears may become trapped beneath contact lenses and damage the corneas. Foreign particles may scratch or soil contact lenses. Chemical fumes may damage contact lenses and irritate the eyes, causing excessive tearing which may dislodge one or both lenses. Accidental displacement or loss of a contact lens may occur without warning, thereby causing immediate incapacitation by sudden change of vision, excessive tearing, light sensitivity, and involuntary squeezing together of the eyelids.

Another important factor often overlooked where use of contact lenses in industry is concerned is "spectacle blur." The vision of either eye may be blurred when contact lenses are removed. Although the change in visual acuity is not extreme, the blurred vision may persist for as long as an hour. Should employees wear contact lenses while driving to work and then remove them, or wear them at work and remove them before driving home, the potential for accidents is obvious.

All individuals who are permitted to wear contact lenses while working in an industrial setting should be identified. The company doctor, the nurse, the safety director, and especially the employee's immediate supervisor, should know which workers are wearing contact lenses. It is likewise important to detect the contact lens wearer at the time of preplacement and periodic physical examination. Failure to do so can cause many problems, not the least of which is a possible discrepancy between a worker's recorded visual acuity with contact lenses in place and his true visual acuity — recorded without them — after an accident. Unless medical records substantiate what the facts really are, an apparent reduction of vision from an accident could result in an overly generous compensation award. (While contact lenses are difficult to detect, the edge of the hard plastic variety becomes visible when the beam of a pocket flashlight is brought to the side of the eye. Soft contact lenses are even more difficult to detect.)

Employees allowed to wear contact lenses in industrial shops must have immediate access to appropriate corrective safety spectacles of industrial quality, that is, in full compliance with the OSHA-referenced ANSI Z87 standard for eye and face protective devices.

The NSPB believes that unless conventional safety eyewear also is worn, optimum eye safety control in industry would absolutely prohibit the use of contact lenses by any shop employee. This position is backed by a recommendation of the American National Standards Institute Z87.1-1979 standard for eye and face protection: "4.4 — Contact lenses, of themselves, do not provide eye protection in the industrial sense and shall not be worn in a hazardous environment without appropriate covering safety eyewear." OSHA and NIOSH have recognized the dangers posed by contact lenses when working with chemicals. In the *NIOSH/OSHA Pocket Guide to Chemical Hazards*, DHEW (NIOSH) Pub. #78-210. the following statement applies to almost all of the 380 chemicals listed, "Contact lenses should not be worn when working with this chemical." In addition OSHA prohibits the wearing of contact lenses when a respirator is being used in a contaminated atmosphere.

APPENDIX C

(Sample)
ACTIVITY INVENTORY

of H. T. GOUGH—EARTH SCIENCE I (Ninth Grade) Five Sections

Laboratory activities scheduled: Activities 1.1, 2.2-2.6, 3.1-3.2, 4.1-4.2, 5.1-5.6, 6.1-6.4, 7.1-7.7, 7.12, 9.1-9.8, 10.1-10.7 as described in *Interaction of Matter and Time.*

Procedure: See teacher edition of *Interaction of Matter and Time.*

Materials needed: See attached Appendix D from *Interaction of Matter and Time.* Sections 8, 11-12 have been omitted and special equipment for these sections is not on hand.

Laboratory caution statements: PG126A — (caution-caustic) warning to teacher in preparing dilute solutions of sodium hydroxide and hydrochloric acid. No caution statements are in student text.

ENRICHMENT ACTIVITIES

Rules

1. All students who wish to participate in the Science Fair and/or Virginia Junior Academy of Science will submit a written proposal for a project by December 21. The proposal shall include the following list of things:

   a. A brief statement of the purpose of the project is "To determine the best angle for a solar collection during the month of January."

   b. A brief description of the procedure to be followed is: Example: "A solar collector will be constructed as described in Science Activities in Energy 'Solar Energy II.' It will be placed in full sunlight for seven days in January at seven different angles and the temperature of the water measured each day."

   c. A description of where the project will be done is: Example: "The collector will be built in my father's workshop. The experiment will be done in study hall."

2. Students may not be issued caustic, corrosive, flammable, or other chemicals which the teacher considers hazardous unless such activities are supervised by the teacher.

3. Projects which the teacher considers hazardous will not be approved.

4. Only approved projects may be entered in school-sponsored events.

Student errands

Student volunteers are used in Earth Science I to:

1. Carry messages, including the section absentee report, to the school office.

2. Fetch audiovisual equipment from the school library.

3. Transport the equipment truck from Room 302 to Room 116. (Why can't I have all my classes in one room?)

4. Go upon the roof and read our weather instruments.

5. Carry messages to other teachers including the assistant track coaches.

6. Prepare track for track meets.

Restrictions: Students are not allowed to leave the school grounds without the principal's permission.

Field trips

1. General rules:

   a. Parental permission slips are required for all trips off school grounds.

   b. Only adult drivers will be used for transporting students.

   c. Students must follow all directions given by the teacher including the wearing of appropriate clothing.

2. Field trip schedule:

   a. Soil profile and observing the landscape activities shall be conducted on the school grounds (the open area behind the track). This is a gently rolling field covered with assorted grasses and weeds (kept mowed). There is a road back of the school.

   b. A water-shed observation will be made on Pidlin Creek (1 mile east of school on Johnson's farm). This 2.5 acre site is the headwaters area of Pidlin Creek and has several ill-defined channels. The amount of water in the channels is dependent on rainfall but does not exceed 12 centimeters in the deepest pool. It is a maturing hardwood forest with river birch, tulip poplar, red maple, and remnants of alder. A steep slope on the south side has an abundance of poison ivy and honeysuckle climbing into the river birch but does not reach the stream channels. A road has been cut (for the hauling of firewood) alongside the main channel to a ford at the downstream end. The copperhead moccasin is the only poisonous animal known to frequent the area.

      No special equipment is used on these trips.

   c. A field trip also is scheduled for the geology museum at Pidlin University. A school bus has been requested. Three parents will be recruited for extra supervision on each busload of students.

APPENDIX D

(Sample)
LABORATORY SAFETY CHECKLIST

	Acceptable	Not Acceptable
General Environment		
1. Aisle space adequate for movement and exit	_____	_____
2. Emergency exits adequate, identified, and accessible	_____	_____
3. Hazardous operations isolated or protected	_____	_____
4. Hazardous operations between working area and exit	_____	_____
5. Sinks and pegboards not used for permanent storage	_____	_____
6. Frequency of testing eyewash fountains and safety showers	_____	_____
7. Sufficient eyewash fountains and safety showers easily accessible, identified, and working properly	_____	_____
8. Controls for major services accessible	_____	_____
9. Adequate fire and safety equipment available and readily accessible	_____	_____
Hoods		
1. Adequate air flow for material being processed	_____	_____
2. Uncluttered, uncrowded, clean storage	_____	_____
3. Services controlled from outside of hood	_____	_____
4. Fan indicator light operating	_____	_____
5. Hood used for improper purpose (such as perchloric acid, etc.)	_____	_____
6. Sash operates properly, condition of counterweight cables, marked for opening of minimum air, velocity, etc.	_____	_____
Services		
1. Piping and electrical services labeled and identified	_____	_____
2. Switches and circuits properly labeled	_____	_____
Electrical		
1. Condition of wiring (worn, frayed, abraded, or corroded)	_____	_____
2. Proper grounding — 3 wire system used on all equipment	_____	_____
3. Temporary setups, overloaded circuits, bread-board wiring	_____	_____
4. Indicator light for each piece of equipment	_____	_____
5. Possible shock hazards from pipes, wet areas	_____	_____
6. Temporary lighting or power connections	_____	_____

	Acceptable	Not Acceptable
Chemical Reagents and Stocks		
1. Properly located, within easy reach, heavy containers at bottom		
2. Trays under reagent bottles		
3. Reagents properly and clearly identified		
4. Minimum quantities on hand		
5. No incompatible or inherently dangerous chemicals		
6. Separators used to prevent breakage		
7. Flammables stored in safety cans and safety cabinets		
8. Storage away from light, heat, oxidizers, etc.		
9. Chemicals requiring periodic venting labeled and vented frequently		
10. Frequent inspection for leakage or deterioration (such as sediments, discoloration, etc.)		
Miscellaneous Practices		
1. Pipette fillers used where indicated		
2. Guards on desiccator		
3. Safety pouring spouts for bottles		
4. Electrical mantles for heating, distillations		
5. Trays under mercury systems		
6. No unattended reactions		
7. Safety shields available and used		
Disposal Practices		
1. Separate containers for waste glass, chemicals, solids, etc.		
2. Proper disposal of solvents (no dumping into sinks)		
3. Approved procedures for disposal of large amounts of chemicals		
4. Approved procedures for disposal of toxic and explosive chemicals		
5. Samples properly labeled and disposed of regularly		
6. Condition of drain system		
7. Drain systems trapped properly		
Safety Equipment		
1. Face shields, goggles, masks and/or breathing apparatus available and inspected regularly		
2. Fire blankets available and inspected regularly		
3. Protective clothing such as apron, gloves and mittens available		
4. Standard procedures for use of protective clothing published and enforced		
5. Proper type fire extinguishers available, readily accessible, and inspected regularly		

	Acceptable	Not Acceptable
General Procedures		
1. Employees informed of procedure to be followed in case of power outage	_____	_____
2. Emergency procedures established in case of fire, breakage, or runaway reaction	_____	_____
3. Evacuation procedures established and drills held regularly	_____	_____
4. All personnel informed as to dangers and proper emergency procedures	_____	_____
5. Proper caution signs posted, updated regularly	_____	_____
6. Safety signs posted and legible	_____	_____
7. Chemicals and solutions issued from a central source	_____	_____
8. Chemicals labeled as to hazards when issued	_____	_____
9. Employees trained in first-aid procedures	_____	_____
10. Emergency first-aid chart posted	_____	_____
11. Eating and/or smoking permitted in proper areas only	_____	_____
12. All personnel have a general understanding of toxic, corrosive, and explosion hazards	_____	_____
13. Chemical usage controlled and an accurate inventory maintained	_____	_____
Equipment		
1. Flammables stored in an explosion-proof refrigerator	_____	_____
2. Food stored in refrigerator	_____	_____
3. Explosion-proof equipment used where necessary	_____	_____
4. Temperature-limiting devices, fuses, relief valves, properly located, installed, and inspected	_____	_____
5. Compressed gas cylinders properly labeled and secured in an upright position	_____	_____
a. Empty cylinders so marked and removed properly	_____	_____
b. Tubing and valves adequate and valve protection caps in place when not in use regardless of whether cylinders are empty or full	_____	_____
c. Safe operating procedures posted	_____	_____
d. All compressed gas cylinders meet current ICC and CGA regulations	_____	_____
6. No chipped and/or scratched glassware and glass utensils being used	_____	_____
7. Bottles properly filled (allowance for expansion)	_____	_____
8. Laboratory hand tools in good condition	_____	_____
9. Handling equipment such as bottle carriers, carboy tilter, clamps, supports, etc., adequate in proper condition	_____	_____
10. Pressure vessels inspected by approved sources and comply with proper codes	_____	_____
11. Personnel barricades used when pressure vessels in operation	_____	_____
12. Tubing and connections in usable condition and properly used	_____	_____

Adapted from Anaheim Union High School District "Laboratory Safety Checklist" Anaheim, California.

As required by federal laws and regulations, the Virginia Department of Education does not discriminate on the basis of sex, color, race, religion, handicapping conditions, or national origin in employment or in its educational programs and activities.

The activity which is the subject of this report was supported in whole or in part by the U.S. Department of Education. However, the opinions expressed herein do not necessarily reflect the position or policy of the U.S. Department of Education and no official endorsement by that agency should be inferred.

BEST COPY AVAILABLE